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The present writer dissents radically from the author's fundamental conclusions and from his estimate of the present drift of opinion, but finds the book interesting and suggestive, and its contributions to Pleistocene paleontology notably valuable. T. C. CHAMBERLIN.

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*The Post-Pliocene Diastrophism of the Coast of Southern California.* By

ANDREW C. LAWSON. Bulletin of the Department of Geology,  
University of California Vol. 1, No. 4, pp. 115-160, plates 8-9.

In this bulletin, Professor Lawson presents the results of some of his studies on the west coast of California. The essay concerns itself especially 1° with the coasts of San Diego and Los Angeles counties, and with the islands of San Clemente and Santa Catalina which lie a few miles to the west; and 2° with the coastal region from Santa Cruz to the Golden Gate. So far as concerns the southern region, the data are drawn principally from four localities. These are: a) the coastal slope of San Diego county,—the San Diego mesa; b) San Pedro Hill; c) San Clemente Island; d) Santa Catalina Island.

The San Diego mesa is a terraced plain having a breadth of from twelve to eighteen miles. It is characterized as a Pliocene delta, made up principally of Pliocene sands and sandstones, but covered by a thin sheet of river gravels. The evidence for the statement that these gravels are of fluvial origin is not given. The gravels are thought to have been deposited approximately at sea level. They now stand at a maximum elevation of nearly eight hundred feet. The inference is that an elevation of eight hundred feet has taken place along the coast of San Diego county since Pliocene time. Various marine terraces at levels of seven hundred feet and less characterize the mesa.

San Pedro Hill is an abrupt headland on the coast of Los Angeles county. Its slopes likewise show a series of marine terraces and sea-cliffs. The highest terrace on this headland stands at an elevation of 1240 feet. There are many lower terraces on the San Pedro Hill, the lowest mentioned having an altitude of 120 feet. Through the higher terraces the streams have cut for themselves cañons; but they flow over the lower terraces in shallow channels. This is evidence of the recency of the elevation marked by the lower terraces. Molluscan borings in the old sea-cliffs, up to an elevation of 1240 feet, may still be seen.

From the relations of the Miocene to the Pliocene formations of the headland, it is inferred there was an "important interval of denu-

dation between the Miocene uplift and the depression which permitted the deposition on the lower flanks of the hill of the formations which paleontologists recognize as of Pliocene age. The recovery from this Pliocene depression is the uplift which is registered in the elevated strands of the hill." The uplift following the Pliocene depression is regarded as Pleistocene. This conclusion is of course warranted, if the Pliocene strata involved are known to belong to the closing stages of the Pliocene period. Otherwise it does not appear that the conclusion is a necessary one. Pleistocene strata are referred to as overlying the Pliocene, and as belonging to a recent stage of the uplift. Between the Pliocene and the Pleistocene no evidence of subaërial denudation exists.

On the west side of San Clemente Island seventeen well marked terraces occur, the highest at an elevation of 1320 feet. These terraces are from 200 to 1500 feet in width. There are less distinct terraces up to a height of 1500 feet. "The total amount of horizontal sawing which has been effected on the slopes of the island by wave action during its elevation through the last 1320 feet," is more than two miles.

Santa Catalina Island is of about the same size, trend, and height as San Clemente. It has a position midway between San Pedro Hill and San Clemente; but on Santa Catalina "there is no trace of an elevated wave-cut terrace, sea-cliff, or strand line of any kind observable." Furthermore, "The stream topography of the island is very much more advanced, *i. e.*, much more ancient than that of either San Pedro Hill or San Clemente."

The absence of terraces and sea-cliffs cannot be attributed to the character of the rock, and their absence is in harmony with the condition of the stream valleys, which indicate that the island has not been below the sea in recent times; that is, "Santa Catalina has not been subjected to the uplift which has affected the two prominent insular masses, one twenty-five miles to the north of it, and the other twenty-five miles to the south of it." Not only has Santa Catalina not been elevated while San Pedro and San Clemente were undergoing the great uplifts which have been mentioned, but it is believed to have actually sunk while these other land masses were being lifted. The evidence of sinking is found in the drowned valleys of certain parts of the coast, and in the falls and rapids which mark the termini of the streams of other parts. Santa Catalina would appear to be situated in

the trough of a syncline which has been actually sinking while the lands on either side were rising.

The coast of the Bay of Monterey is also marked by a series of terraces. Four of them, the highest of which reaches an elevation of 712 feet, are very distinct, and abut against sea-cliffs. Higher terraces extend up to an elevation of 1201 feet. The river valleys also of the Santa Cruz region are found to afford evidence in harmony with that already cited from the regions further south. The general tenor of the evidence presented by this part of the coast is therefore in harmony with that presented by the more southerly region. Here also there has been a marked epeirogenic movement in recent times.

On the peninsula of San Francisco, marine Pliocene rocks, having a thickness of more than one mile, are said to exist. It is believed that subsidence accompanied the accumulation of this great series. These strata now occur at an elevation of over 700 feet. Not only this, but the strata have been so tilted, and subsequent erosion has been so great, that the base of the series, as well as the top, is exposed at this elevation. The elevation is said to have been post-Pliocene. Of course this is true, if the uppermost Pliocene strata involved represent the close of the Pliocene period.

According to the author, the relations of the Pliocene strata indicate great orogenic as well as epeirogenic movements in this region since their deposition. Montara Mountain is believed to have been produced during the orogenic event by which the Pliocene rocks (Merced series) were lifted into their present position. The granite axis of the mountain is regarded as the up-thrust base on which the Pliocene strata were laid down. All the adjacent younger strata dip away from this granite axis quaquaversally. While, therefore, the general structure of the mountain is comparable to that of a laccolite, it is, according to Professor Lawson, very different from it genetically.

On the basis of the facts given in the paper, there would appear to be no ground for doubt concerning the main conclusions at which Professor Lawson arrives concerning the movements of the coast in recent times. On the basis of evidence presented, there might be some question as to the post-Pliocene date of all these changes of level, did not Professor Lawson define the Pleistocene so as to include them. He says (p. 159), "It is not an easy matter to delimit the Pliocene and Pleistocene epochs so that they shall correspond to the same divisions of the geological scale in the eastern part of the continent. . . . The rea-

son for this is that there has been no distinct break in the continuity of marine conditions throughout the epochs, only a gradual transition of conditions. In this gradual transition there was, however, a reversal of the epeirogenic movement of the coast from a process of depression to a process of uplift. This turning point of the disastrophic pendulum . . . . is believed to correspond well with the beginning of the Pleistocene." With this definition of the Pleistocene, of which we are not disposed to complain, there can be no doubt as to the age of the remarkable changes of level which Professor Lawson describes. It is to be hoped that at some future day he may give us an account of the corresponding phenomena along a greater and connected stretch of the California coast. The results announced in this paper purport to be no more than the results of a general reconnaissance of the regions described.

ROLLIN D. SALISBURY.